INSTRUCTIONS FOR THE USE OF THE PROGRAM

DISCLAIMER

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ACRONYMS

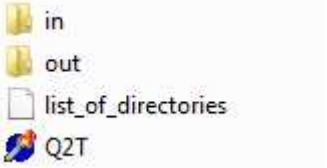
The acronyms in the following table are used throughout this document:

SFDN	space filling drainage network, i.e., the connected set of steepest directions theoretically followed by runoff
CN	channel network: a subset of the *SFDN*
DEM	a data set (here a file in ASCII raster format) containing the "depitted" terrain elevation, from which the *SFDN* and the *CN* are computed.
Q2T	the name of the program (Qual_2_Tree)

PROGRAM INSTALLATION

The compressed file *Q2T.zip* contains the files needed for running the code in a *WINDOWS* environment, along with 3 *DEMs* (with extension.grd: see below), which are the test cases presented in the paper.

The user should either uncompress the file at the root of a C disk or uncompress the file at any other directory of a disk
In the first case, a directory called Q2T is created and the program is ready to use, by clicking on the *Q2T.exe* icon inside that directory.
In the second case, the user has to modify the 2 paths within the text file named "*list_of_directories*", as suggested in the following lines:

1	Let us suppose that the files have been uncompressed within the directory D:\programs\dummyname2\water_quality\Q2T\ (in general we recommend not to use a path longer than 120 characters). In this directory you will find these data  Q2T.exe is the executable file and *list_of_directories* is an ASCII file with the names of two sub directories, necessary for the input-output operation of the program. The input file will be contained in the "in" sub-directory and the results of the water-quality computations will be in the "output" sub-directory. Some intermediate files containing geomorphological information are created by the program and written in the "in" sub-directory.	

2	Using a text editor, open the file *list_of_directories* and change the default paths C:\Q2T\in C:\Q2T\out with D:\programs\dummyname2\water_quality\Q2T\\in D:\programs\dummyname2\water_quality\Q2T\\out	

That's all. No other operation is needed for the installation. The program is now ready to use, by clicking on the *Q2T.exe* icon. In order to use the program, please have a look at the following pages and then refer directly to the test cases. The program is very simple to use.

FORMAT OF INPUT DEM FILES

The program works on ASCII DEM files, written according to the non-proprietary ARC/INFO ASCII GRID format, with *grd* extension. See the *.grd* files provided as test case or read http://en.wikipedia.org/wiki/Esri_grid.
It is fundamental that

1) the DEM has already been depitted, i.e., that a connected path with positive slopes already exists joining the cells of the DEM to the basin outlet.
2) the basin outlet must be located along the outer boundary of the basin (not necessarily of the DEM!).

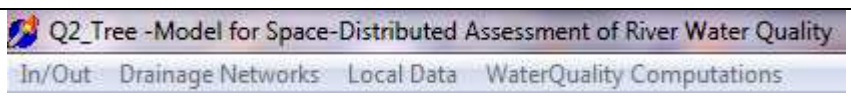
PROGRAM LIMITATIONS

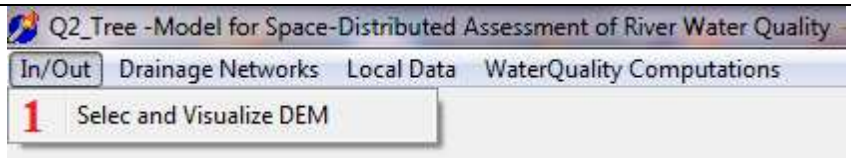
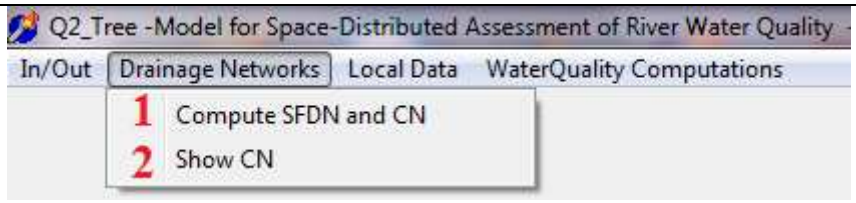
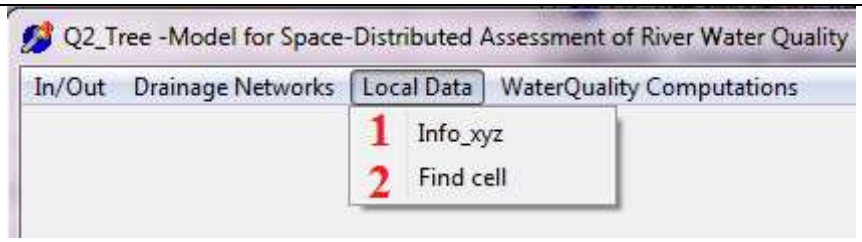
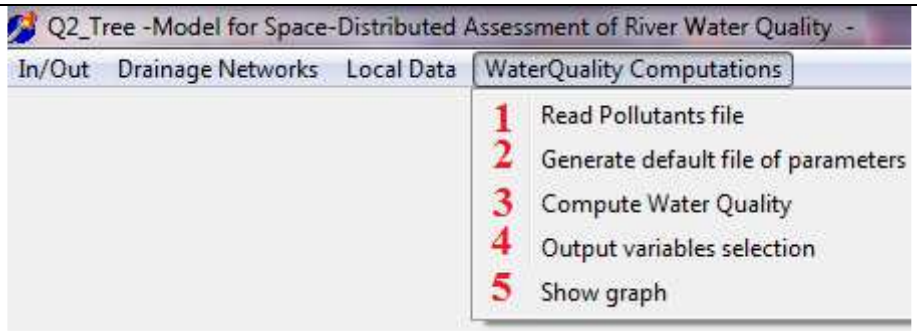
The program can operate on DEM with number of rows and columns up to 1500 x 1500.
The program was written in DELPHI and was tested under WINDOWS 7, WINDOWS 8 and WINDOWS 10 OS.

Please, note that this program has been written for scientific and technical use only. Starting from an original version, this program has been tested and made as much user-friendly as possible. However, some details could certainly be improved by professional programmers who are not the Authors of the paper. For instance, we couldn't program the dynamic zooming of the panels, but we don't think this is a real limitation.

PROGRAM USE AND TUTORIALS

The program is provided along with 3 separate short stand-alone tutorials, by which the user can understand how the program works and what are the available options. Tutorials 1, 2 and 3 make reference to the test cases discussed in the paper.
The use of the code is straightforward. In the following, the '.' is used to indicate the decimal place and groups of thousands are not separated. This is the type of convention used throughout this manual. There are 7 main options that are here presented in a visual way and explored in the tutorials.

A		*The main panel of the program shows 4 set of commands, briefly presented in the following.*

B		*IN/OUT:* *1 is used for the selection and the visualization of the DEM on the screen*
C		*DRAINAGE NETWORKS* *Command 1 finds the outlet of the watershed and activates the computation of the SFDN and CN. Command 2 shows the identified CN*
D		*LOCAL DATA* *Command 1 is used to browse the DEM elevations in the neighbourhood of a cell* *Command 2 is used to find the location of a cell on the basis of its coordinates (matrix or geographic)*
E		*WATER QUALITY COMPUTATIONS* *Command 1 is used to read the user-defined list of pollutant sources and water diversions.* *Command 2 generates the list of parameters used by the solver* *Command 3 solves the equations of the model* *Command 4 allows the selection of the quantities to be written on the print-out of the simulation* *Command 5 shows the x-y graphs for the 6 variables*

		solved by the model
F		*In order to quit the program, click on the red button at the upper right corner of the DOS windows that appear for print out of the results during the execution of the program*

LIST OF OUTPUT FILES

During the pre-processing of the DEM, several ASCII files are written on disk. These files allow a complete description of the SFDN and CN of the watershed (files with extension *1sf*, *2sf*, *1dr* and *2dr*). Finally, during the Water Quality Computation process, the files containing the results along the selected subset of the CN are both in a format directly readable by MATLAB and as a text file with explicative captions (files with extension *out*).

directory	*name and extension*	*content*
out	***namefile*.1sf,** ***namefile*.2sf**	complete topological description of the SFDN
out	***namefile*.1dr,** ***namefile*.2dr**	complete topological description of the CN
in	***namefile*.esp** ***namefile*.rad**	These two files are needed for the shading of the watershed relief during the DEM visualization phase.
out	***namefile*+*row_col*.out**	This file is an ASCII file containing all the data required by the user with Command 4 of panel E above (in the following, E.4). *row* and *col* are the number of the row and of the column in the DEM of the initial point of the selected path along the CN for the variables printout. The format of this file is explained in the following
out	***namefile*+*MATLAB*.out**	This file is an ASCII file containing all the data required by the user with Command 4 of panel E above (in the following, E.4). The file has the same informative content of the previous one but does not contain any explicative label, so that it can be easily read by any visualization program. A possible set of reading instructions for MATLAB are provided in the following
out	***namefile*.wqp**	This file is an ASCII file created for internal use by the program. For each point along the selected CN, it contains all the preliminary data needed for the use of the solver. The format of this file is explained in the following

FORMAT OF SOME OUTPUT FILES

***namefile*+*row_col*.out**	This file is an ASCII file containing all the data required by the user with Command 4 of panel E above (in the following, E.4). Accordingly, the format of this file can vary if only some variables are required. In the following we will make reference to the case that all the variables have been selected by the user to be written on the file. The files contains the data starting from the point selected by the user on the CN (*row* and *col* are the number of the row and of the column in the DEM of the initial point), down to the watershed outlet. At the beginning of the file there is a list of the variables: 1 north [m] 2 east [m] 3 distance [km] 4 z [m] 5 Q [m^3/s] 6 Area [m^2] 7 slope [m/m] 8 width [m] 9 Ks [m(1/3)/s] 10 T of water along the river [°C] 11 Y [m] 12 U [m/s] 13 tao [Pa] 14 Rair._coeff. [-] 15 Ox. Satur. [mg/L] 16 CBOD [mg/L] 17 Norg [mg/L] 18 NH4 [mg/L] 19 NO3 [mg/L] 20 DO [mg/L] 21 SOD [g/(m2)/day] 22 # of discharge points upstream of current station 23 dt of transit between local cell and the following 24 T of air [°C] 25 T of contribution q [°C] 26 Short Wave [W/m2] 27 Long Wave [W/m2] 28 Sensible Heat [W/m2] 29 Latent Heat [W/m2] These data are then listed in matrix format listed under the corresponding identificative number. For instance, if only the north, east and Q have been required, the file will look like 1 2 5 5128940.000 1619340.000 0.1085 5128780.000 1619340.000 0.1092 …. After the last line of this matrix, a list of the parameters used in the solution of the equations is listed.

***namefile*+*MATLAB*.out**	This file is like the one described above, but contains only the matrix of the required variables. This makes it easier to read it automatically by some program used for data visualization. For instance, if MATLAB is used, this file can be easily read by the set of instructions
	
	`namefile 'C:\Q2T\out\vallecamonica_160m_MATLAB.out';`
	`load(namefile);`
	
	so that single vectors can be easily handled and plotted. For instance, if all the variables have been selected by the user with command E.4 above, single vectors can be read as:
	
	`z = risultati(:,4);`
	`Q = risultati(:,5);`
	`Area = risultati(:,6);`
	`slope = risultati(:,7);`
	`width = risultati(:,8);`
	`ks = risultati(:,9);`
	`T = risultati(:,10);`
	`depth = risultati(:,11);`
	`U = risultati(:,12);`
	`bed_shear_stress = risultati(:,13);`
	`Rair_coeff = risultati(:,14);`
	`Ox_saturation = risultati(:,15);`
	`CBOD = risultati(:,16);`
	`Norg = risultati(:,17);`
	`NH4 = risultati(:,18);`
	`NO3 = risultati(:,19);`
	`DO = risultati(:,20);`
	`SOD = risultati(:,21);`
	`pollutant_input = risultati(:,22);`
	`dt_transit_time = risultati(:,23);`
	
	`and so on for following columns…`

***namefile*.wqp**	This file is an ASCII file created for internal use by the program. For each point along the selected CN, the following quantities are listed: n r c east north distance z slope Area Tlocal Tinput Ks width Q_immission Ci_imm i=1..6 Q_diversion where *n* is a code used in the coding of the CN, *r* anc *c* are the row and the column in the DEM of the corresponding cell. Q_immission and Q_diversion are the local discharge associated to the pollutant loads or withdrawn from the river at the selected cell. Ci_imm is the concentration of the 6 variables associated to the pollutant load, if present.